Oil Shale Tract C-b

# INFORMATION PACKAGE

ASHLAND OIL, INC. • OCCIDENTAL OIL SHALE, INC.

MAY 1977

# C-b Shale Oil Venture

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Operator
Ashland Colorado Inc.



Ashland Oil, Incorporated
Occidental Oil Shale, Inc.
Operator

Revised March, 1977

INFORMATION PACKAGE

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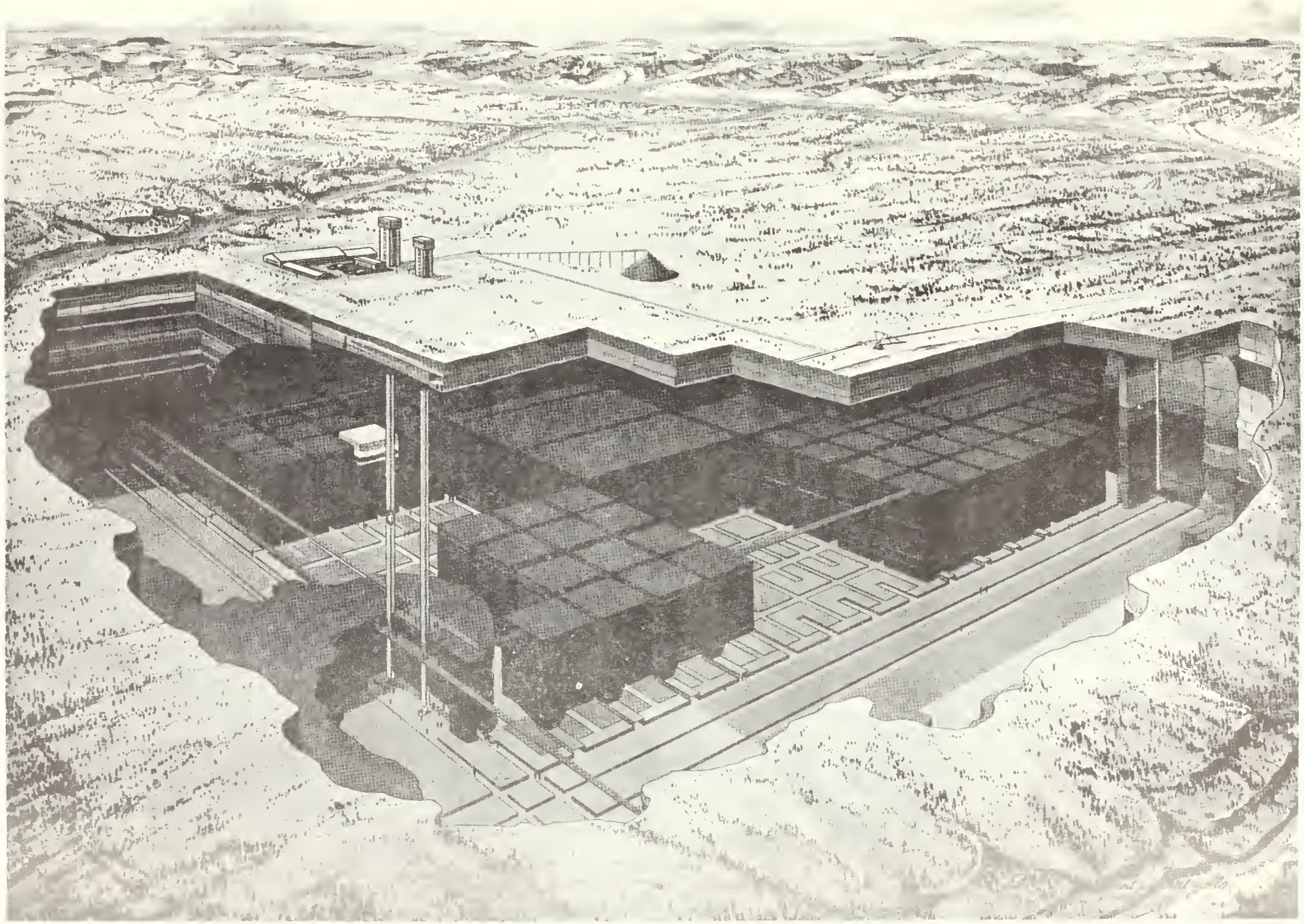


C-b Oil Shale Venture
Occidental Oil Shale, Inc.
Ashland Oil Inc.
Colorado

The Ralph M. Parsons Company
Engineers/Constructors
Pasadena, California

## I. BACKGROUND AND SUMMARY

In recognition of the vast oil shale resources in the states of Colorado, Utah and Wyoming and the potential they offer to help alleviate a growing energy problem, the Secretary of the Interior in 1971 announced plans for a Federal Oil Shale Leasing Program. As stated in the final environmental statement, the goal of the leasing program was to:

> "... provide a new source of energy for the nation by stimulating the timely development of commercial oil shale technology by private enterprise, and to do so in a manner that will assure the minimum possible impact on the present environment while providing for future restoration of the immediate and surrounding area."

In February of 1974, Ashland Oil, Inc. (Ashland) and three other companies (Atlantic Richfield Company, The Oil Shale Corporation, and Shell Oil Company) submitted the highest bid ($117,798,000.20) for the second of two Colorado Oil Shale Lease Tracts offered as part of the U.S. Department of Interior's Prototype Federal Oil Shale Leasing Program. The Prototype Leasing Program is under the direction of the Area Oil Shale Supervisor of the U.S.G.S. Conservation Division, located in Grand Junction, Colorado.

Federal Oil Shale Lease Tract C-b (Figure 1) is located three miles south of the Piceance Creek Road at the PL Ranch turnoff, which is 20 miles west of the Rio Blanco Store (half-way between Rifle and Meeker) on Colorado 13 and 789.

In December, 1975, Atlantic Richfield Company and The Oil Shale Corporation withdrew from this joint venture. On November 2, 1976, Shell Oil Company announced its withdrawal from the C-b Oil Shale Project. On November 3, 1976, Ashland Oil, Inc. announced the formation of a new joint venture with Occidental Oil Shale, Inc. (Oxy) to proceed with development of Tract C-b.

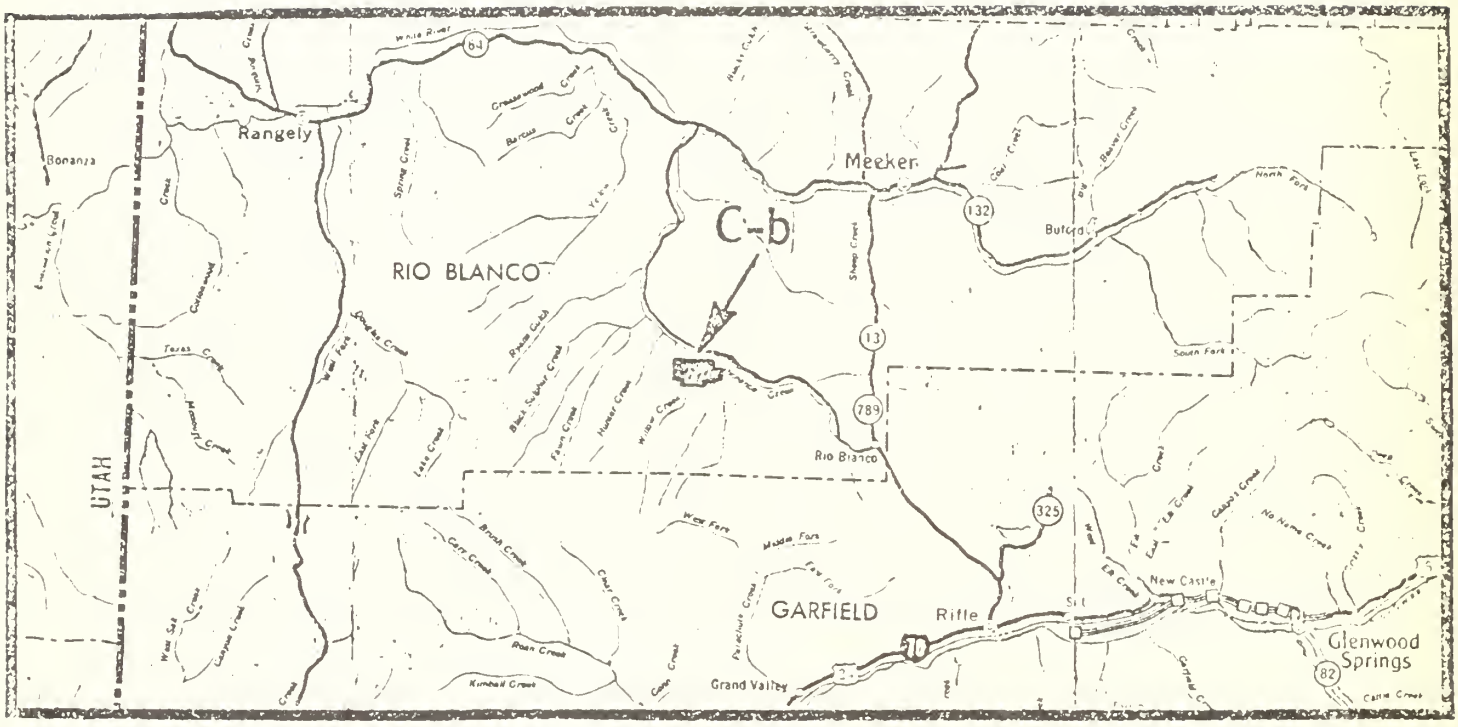
As a result of these withdrawals, Ashland acquired a sole interest in Tract C-b. In this new joint C-b Shale Oil Venture, Ashland granted Oxy a 50% interest in the C-b lease and tract in exchange for the right to use the Oxy Modified In Situ Process, which Oxy has developed and patented for the recovery of oil from shale.

The Oil Shale Lease requires that a Preliminary Development Plan, an Exploration Plan and a Detailed Development Plan be submitted to the Federal Government for approval before full-scale mining or plant construction can begin on the C-b Tract.

All of these Plans must comply with detailed Environmental Stipulations which are part of the Lease. These Environmental Stipulations require the C-b lessees to conduct two years of environmental baseline studies which include plant ecology, animal ecology, aquatic ecology, water quality and air quality. Plans to control erosion and revegetate disturbed areas are required to be developed. A Fish and Wildlife Management Plan must also be submitted and approved. The Environmental Stipulations further require that, after mining and processing activities are completed, the

FIGURE 1

LOCATION OF TRACT C-b




Federal Oil Shale Lease Tract C-b (Figure 1) is located three miles south of the Piceance Creek Road at the PL Ranch turnoff which is 20 miles west of the Rio Blanco Store (half-way between Rifle and Meeker) on Colorado 13 and 789.

C-b Tract be returned to a condition as nearly equivalent to its original state as possible so that it can support the same kinds and number of animals as now exist on the Tract.

A Preliminary Development Plan was submitted to the Area Oil Shale Supervisor shortly after award of the Lease. It described tentative development plans, the types of planned activities, and an approximate time schedule that was subsequently carried out.

The Exploration Plan, covering activities during the first two years, defined the extensive environmental data collection programs and the exploration efforts planned to evaluate the oil shale reserves.

The C-b lessees submitted its Detailed Development Plan (DDP) to the Area Oil Shale Supervisor (AOSS) on February 9, 1976. This plan incorporates the environmental baseline data collected during the first year and describes a plan for commercial development for Tract C-b. Public hearing on all aspects of the DDP were held in April, 1976.

The Lessee of Tract C-b requested on March 2, 1976, and were granted effective September 1, 1976, a suspension of operations pursuant to Section 39 of the Mineral Leasing Act (30 USC 209) and Section 22 of Oil Shale Lease Number C-20341. This suspension was requested in the interest of resource conservation for the primary purpose of allowing the Lessee an opportunity to consider alternatives that might achieve a greater ultimate recovery of the oil shale resource in an environmentally acceptable manner.

On November 22, 1976, the AOSS notified the Lessee as follows:

> "The Area Oil Shale Office has completed the required review of the Detailed Development Plan which you submitted for Colorado Oil Shale Tract C-b on February 9, 1976, and has found that, with the additions developed during the review process, the plan meets the terms and conditions of the oil shale lease. Its implementation, however, requires resolution of issues which resulted in a 1-year suspension of operations effective September 1, 1976".

Recently, a Modification to the DDP was submitted to the AOSS to address those areas of change brought about by the use of the Oxy process for development of Tract C-b. This change in plan for the development of Tract C-b is the result of actions envisioned by the Lessee when an application for suspension of operations was requested on March 2, 1976. Although some geotechnical confirmation work needs to be completed, the Lessee believes this plan resolves the matter of conservation of resource.

This revised plan outlines the use of the modified in-situ technology developed by Occidental Oil Shale, Inc. for recovering oil from the shale. The following are important milestone events for this revised development plan.

| | | |
|---|---|---|
| September | 1977 | Mobilization and Start of Shaft Sinking |
| April | 1979 | Begin Construction of Initial Retorts |
| May | 1980 | Ignite Initial Retorts |
| September | 1982 | Start Full-scale Operation |

The project is expected to have a capital cost of $443 million and create 1600 permanent jobs prior to reaching full capacity of 57,000 Bbl/day in 1983.

## II. OXY's MODIFIED IN-SITU PROCESS

The modified in-situ process is the result of 4-1/2 years of extensive field testing and basically consists of creating an underground chimney of broken oil shale by expanding the oil shale into a previously mined out void volume utilizing conventional explosives. A predetermined void volume is mined out either under, or through, the oil shale deposit depending on the height and other geological conditions.

Retorting is initiated by heating the rubble pile at the top of the retort using an outside energy source. After a short period of time the outside energy is discontinued and the combustion process is maintained by introducing air or an air/recycle mixture to the retort. The residual carbon becomes the major fuel required for retorting. The combustion zone moves slowly downward, and the oil produced in the retorting zone flows by gravity to the bottom of the retort where it is collected in a sump and pumped to storage.

The off gas may be burned in a turbine for electric power generation, or used for steam generation. About 25% of the generated electric power would be used to operate the in-situ process, and the other 75% would be exported to the Western Colorado power grid.

## III. SUMMARY OF PAST ACTIVITIES FOR TRACT C-b

### A. Pre-exploration Phase Surveys

Pre-exploration reconnaissance investigations encompassing plant ecology, animal ecology, aquatic ecology and archaeology were done prior to the initiation of any disturbance on the Tract, (e.g., road improvement and core hole drilling). A team of plant, animal and aquatic ecologists, and an archaeologist surveyed each site to be disturbed in order to (1) determine what species are present, and if any of the areas are vital habitat for rare, endangered species; (2) develop a description of the plant communities present on the sites to aid in later rehabilitation; and (3) determine whether the area has any archaeological significance. Several work areas were relocated as a result of the teams' recommendations.

### B. Drilling/Mining Engineering

A series of core holes were drilled on Tract C-b to determine the extent and quality of the oil shale reserves and mining characteristics of the surrounding rock strata. Data are also being collected on the quantity and quality of water present in the rock strata beneath the Tract. This information and data currently being obtained from several large diameter core holes will be utilized to design the underground oil shale mine planned for Tract C-b.

### C. Environmental Baseline Studies

The Environmental Stipulations of the Lease require the C-b Shale Oil Project to collect baseline data for one year, prior to the submittal of a Detailed Development Plan for the C-b Tract. The various programs started between April - November of 1974 include:

#### 1. Water Quality Studies

A comprehensive surface and ground water data collection program was initiated. The surface water program consists of thirteen stream gauging stations installed on all drainages flowing onto and off Tract C-b. These stations are measuring water flow, sediment, pH and salinity. Technicians from the U.S.G.S. Water Resources Division also collect water quality samples for more detailed analysis. The ground water program was intimately associated with the exploratory drilling phase of the project. Core holes required for the mining and engineering analyses were completed as ground water observation wells. They were designed for long term monitoring of various subsurface aquifers on the Tract. Additional monitoring wells have been drilled along the stream valleys and gulches and near the proposed mining areas. Water quality samples have been collected and water level and quantity measurements taken during the drilling of each of these wells.

2. Air Quality Studies

A baseline air quality and meteorology program was initiated in order that potential impacts of commercial oil shale operations might be determined. In order to satisfy this requirement, Radian Corporation was hired to install and operate monitoring equipment at five locations on the C-b Tract and along Piceance Creek. These monitoring stations were designed to obtain information in addition to that which is required by the Lease Stipulations.

3. Vegetation Studies

The vegetation study on Tract C-b was carried out by Woodward-Clyde Environmental Consultants, their associated contractors and by the C-b Lessee's staff personnel. Information collected includes: types of vegetation and their occurrence (for instance, valley bottom sagebrush and pinyon-juniper); the use of certain species such as service berry, mountain mahogany and bitterbrush by wildlife; natural changes now occurring in the vegetation types; identification of all species of plants; which plants are more common on the Tract; and the productivity of different species of plants. This information will allow us to properly plan the Tract development in such a way as to minimize adverse impact.

4. Wildlife Studies

Woodward-Clyde Consultants studied the animals which are found on the Tract and its surrounding area. The objectives of these studies were to determine what kinds of animals live in this area, how many there are, how they interact with one another and how important Tract C-b is to these animals as compared to other parts of the Piceance Basin. Studies included such activities as collecting insects; live-trapping and then releasing small mammals such as chipmunks and mice; studying predators (e.g., bobcat and coyotes) by direct observations, observing songbirds, game birds and birds of prey; counting big game (e.g., deer and elk) both from the ground and the air to determine patterns of migration and areas of heavy use; and, studying the livestock use on the Tract area.

5. Aquatic Studies

Studies of animal and plant life, and water quality in all waters which occur in the area surrounding Tract C-b, and all streams draining the Tract as far down-stream as the White River were conducted by Woodward-Clyde aquatic specialists. The objective of these studies was to determine the kinds and numbers of species existing in these waters, how productive the waters are, and how the aquatic system functions. These studies consisted of activities such as collecting samples of insects and plants that live in or on the bottoms of these streams and ponds, electro-shocking and then releasing fish, and taking samples of water for laboratory analysis of algae, bacteria and water quality.

6. Archaeology Studies

Consultants from the Archaeological Department of Colorado State University have completed a survey of Tract C-b for any sites of archaeological, historic, and paleontological importance. No sites worthy of being included in the National Register of Historic Places were found. In addition to this baseline study, future studies will be done on any off-tract areas which might be disturbed during activities such as road improvements or pipeline and powerline construction.

A list of all field activities and facilities associated with the above programs is given in Figure 2.

D. Socio-Economic Assessment

In recognition of the socio-economic impact that an oil shale operation plant could have on a remote location, the Lessees developed a report dealing with socio-economic impacts that will accompany construction, mining and processing of oil shale on Federal Lease Tract C-b in the Piceance Creek Basin. The report consists of two volumes, namely a Baseline Description and an Impact Analysis and represents another point in the process involving industry, local, regional, state and federal efforts to describe, assess, monitor, plan for and manage growth associated with large scale development of oil shale.

1. Volume I - Baseline Description

The Baseline Description is a document setting out features of Garfield, Mesa and Rio Blanco Counties in order that a record may be established against which future events may be measured.

2. Volume II - Impact Analysis

This report presents projections of socio-economic impacts related to development of Federal Lease Tract C-b. The report adds to other efforts at the local, regional, state and federal levels. The information presented deals with impacts occurring primarily from the C-b project, although regional development issues are addressed in the final chapter.

The document discusses many impacts and procedures for managing or mitigating the impacts. However, no set of projections can precisely portray every future occurrence. For example, one of the cited issues involved in forecasting socio-economic impacts is the timing and phasing of industry developments. The actual construction schedule of any single plant will affect the ability of an area to manage growth related to its development. The magnitude and span of the construction phase are important issues relating to growth management. If more than one project begins at approximately the same time, the construction schedules of all of the plants bear heavily on the growth likely to occur as well as the area's ability to deal with it.

FIGURE 2

## TRACT C-B FIELD ACTIVITIES

13 SURFACE WATER GAUGING STATIONS
5 AIR QUALITY TRAILERS
1 200-FOOT METEOROLOGICAL TOWER
12 VEGETATION PLOTS
17 AQUATIC ECOLOGY SAMPLING STATIONS
11 PELLET-GROUP TRANSECTS
10 CORE HOLES
1 PUMP TEST WELL
4 PUMP TEST OBSERVATION WELLS
13 ALLUVIAL WELLS
2 PREDATOR SCENT-POST SURVEY LINES
2 PARASITE SAMPLING SITES
2 WATERFOWL SYSTEMATIC OBSERVATION SITES
5 ANIMAL TRACK COUNT TRANSECTS
2 ANIMAL TRAP SITES
8 SATELLITE ANIMAL TRAP SITES
8 ORNITHOLOGICAL STUDY TRANSECTS
4 MICROENVIRONMENTAL STATIONS

TRACT OFFICES
GUARD HOUSE
3 TRAILERS
POWERLINES

## IV. SUMMARY OF COMMERCIAL PROGRAM

The development of the commercial modified in situ facilities shown on Project Plot Plan, Figure 3, is represented on the Commercial Development Schedule, Figure 4. The Tract C-b development program will extend from September 1, 1977, starting with site preparation, to September 1982, when the mine and surface facilities will be completed to initiate full-scale production.

The property will be mined by developing successive geographic areas of the Tract called panels. A panel will contain several groups of retorts. These groups are referred to as clusters or retort clusters. A retort, the basic unit, is a column of rubbled shale containing a certain void fraction bounded by undisturbed shale. It is envisioned that several clusters each containing eight retorts will be processed concurrently. Clusters will be brought on-line in such a sequence that the number of clusters operating at one time within a panel will produce the designed quantity of shale oil.

### A. Site Preparation and Shaft Sinking

The first site activities, starting in September 1977, will be mobilization and site preparations necessary to get shaft sinking operations underway. Underground development can proceed only after shafts are available.

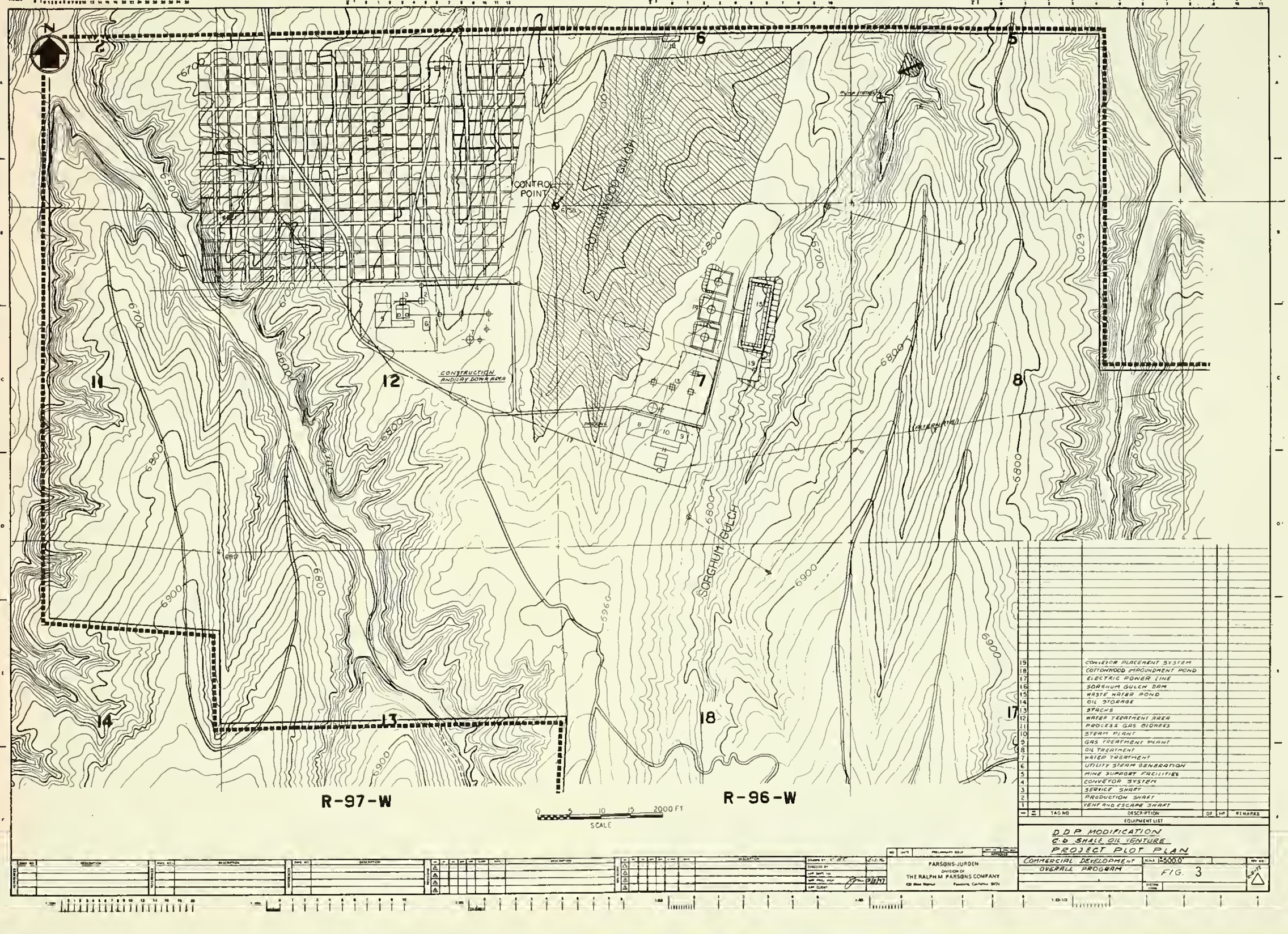
While the shaft-sinking operations are being mobilized, certain site preparation and preconstruction activities will proceed. These will include preparation or extension of service roads, construction of water storage to receive underground water from initial dewatering operations, and necessary grading for temporary construction facilities, fencing, etc.

The Lessees will construct five vertical mine shafts on the tract. A ventilation/escape shaft (12 feet in diameter), a temporary gas shaft (6 feet in diameter), a production shaft (34 feet in diameter), a service shaft (34 feet in diameter), and a gas shaft (34 feet in diameter), as shown in Figure 3.

Of the four major shafts, the first to be completed will be a 12-foot-diameter shaft 500 feet from the northern property boundary. This shaft will perform a dual service during the development period. First, it will serve as a temporary production shaft until the main 34-foot-diameter production shaft becomes available, and later it will serve as a ventilation/escape shaft for the mine.

### B. Ancillary Development

The 12-foot-diameter shaft will be completed first. While the 34-foot-diameter shafts are still being constructed and major mine headings and levels are being opened up, an ancillary facility will be constructed in the vicinity of the 12-foot-diameter shaft. This facility will include two




| | | TAG NO | DESCRIPTION | QTY | SIZE | REMARKS |
|---|---|---|---|---|---|---|
| | | | EQUIPMENT LIST | | | |
| 19 | | | CONVEYOR PLACEMENT SYSTEM | | | |
| 18 | | | COTTONWOOD IMPOUNDMENT POND | | | |
| 17 | | | ELECTRIC POWER LINE | | | |
| 16 | | | SORGHUM GULCH DAM | | | |
| 15 | | | WASTE WATER POND | | | |
| 14 | | | OIL STORAGE | | | |
| 13 | | | STACKS | | | |
| 12 | | | WATER TREATMENT AREA | | | |
| 11 | | | PROCESS GAS BLOWERS | | | |
| 10 | | | STEAM PLANT | | | |
| 9 | | | GAS TREATMENT PLANT | | | |
| 8 | | | OIL TREATMENT | | | |
| 7 | | | WATER TREATMENT | | | |
| 6 | | | UTILITY STEAM GENERATION | | | |
| 5 | | | MINE SUPPORT FACILITIES | | | |
| 4 | | | CONVEYOR SYSTEM | | | |
| 3 | | | SERVICE SHAFT | | | |
| 2 | | | PRODUCTION SHAFT | | | |
| 1 | | | VENT AND ESCAPE SHAFT | | | |

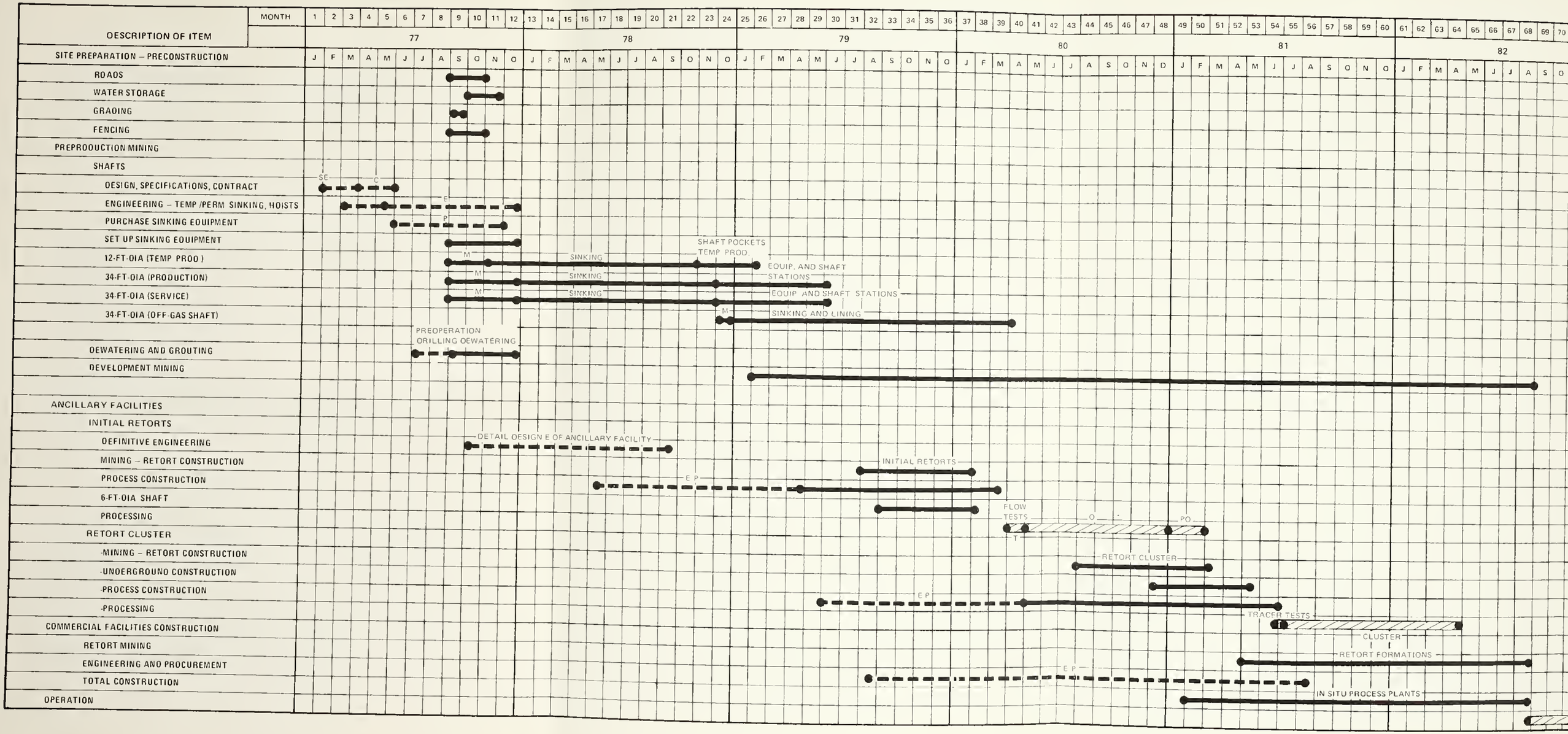
PARSONS-JURDEN
DIVISION OF
THE RALPH M PARSONS COMPANY

D.D.P MODIFICATION
C-b SHALE OIL VENTURE
PROJECT PLOT PLAN

COMMERCIAL DEVELOPMENT
OVERALL PROGRAM

SCALE 1"=2000'

FIG. 3


DESCRIPTION OF ITEM
MONTH
77
78
79
80
81
82
SITE PREPARATION – PRECONSTRUCTION
ROADS
WATER STORAGE
GRADING
FENCING
PREPRODUCTION MINING
SHAFTS
DESIGN, SPECIFICATIONS, CONTRACT
ENGINEERING – TEMP /PERM SINKING, HOISTS
PURCHASE SINKING EQUIPMENT
SET UP SINKING EQUIPMENT
12-FT-DIA (TEMP PROD )
34-FT-DIA (PRODUCTION)
34-FT-DIA (SERVICE)
34-FT-DIA (OFF-GAS SHAFT)
DEWATERING AND GROUTING
DEVELOPMENT MINING
ANCILLARY FACILITIES
INITIAL RETORTS
DEFINITIVE ENGINEERING
MINING – RETORT CONSTRUCTION
PROCESS CONSTRUCTION
6-FT-DIA SHAFT
PROCESSING
RETORT CLUSTER
-MINING – RETORT CONSTRUCTION
-UNDERGROUND CONSTRUCTION
-PROCESS CONSTRUCTION
-PROCESSING
COMMERCIAL FACILITIES CONSTRUCTION
RETORT MINING
ENGINEERING AND PROCUREMENT
TOTAL CONSTRUCTION
OPERATION
SE
C
E
P
M
SINKING
SHAFT POCKETS
TEMP PROD.
EQUIP. AND SHAFT
STATIONS
EQUIP. AND SHAFT STATIONS
SINKING AND LINING
PREOPERATION
DRILLING DEWATERING
DETAIL DESIGN E OF ANCILLARY FACILITY
INITIAL RETORTS
E P
FLOW
TESTS
O
PO
T
RETORT CLUSTER
E P
TRACER TESTS
CLUSTER
RETORT FORMATIONS
E P
IN SITU PROCESS PLANTS

| 71 | 72 | 73 | 74 | 75 | 76 | 77 | 78 | 79 | 80 | 81 | 82 | 83 | 84 | 85 | 86 | 87 | 88 | 89 | 90 | 91 | 92 | 93 | 94 | 95 | 96 | 97 | 98 | 99 | 100 | 101 | 102 | 103 | 104 | 105 | 106 | 107 | 108 | 109 | 110 | 111 | 112 | 113 | 114 | 115 | 116 | 117 | 118 | 119 | 120 | 121 | 122 | 123 | 124 |
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| | | 83 | | | | | | | | | | | | 84 | | | | | | | | | | | | 85 | | | | | | | | | | | | 86 | | | | | | | | | | | | | | | |
| N | O | J | F | M | A | M | J | J | A | S | O | N | O | J | F | M | A | M | J | J | A | S | O | N | O | J | F | M | A | M | J | J | A | S | O | N | O | J | F | M | A | M | J | J | A | S | O | N | O | | | | |

LEGEND

| | |
|---|---|
| E | ENGINEERING |
| S | SPECIFICATION |
| C | PLACE CONTRACT |
| P | PURCHASE |
| ● | START/COMPLETE POINTS |
| M | MOBILIZATION |
| T | TESTS |
| O, PO | OPERATION, POSTOPERATION |

ENGINEERING PROCUREMENT

CONSTRUCTION

OPERATION

Figure 4 C-b SHALE OIL VENTURE
Commercial Development Schedule

or more commercial-sized retorts, retort clusters and attendant equipment to operate them. This will permit the processing of a thick section of high-grade oil shale, establish the environmental monitoring procedures, obtain operating experience, and provide a site for the training of mine and processing personnel.

Later, as the main shafts and other full-scale plant units become available, this ancillary facility will be incorporated into the full-scale facility.

C. Full-Scale Modified In Situ Plant and Operations

The construction period of the full-scale commercial facility will begin with shaft sinking in September 1977 and end September 1982 when the first cluster within the commercial panel is kindled. From this time on mining will no longer be a preproduction activity as part of the construction program; it will then become a production operation. As more clusters are brought on-line production will increase and full-capacity production (57,000 bbl/day) will be achieved in about 12 months, or by September 1983.

Within the 5-year construction period, the ancillary retort facilities will be developed for processing shale oil. These facilities will use the shafts and some increments of the full-scale oil/gas processing units for their operations.

After key development drifts are driven at all levels, the principal work of retort preparation will begin in May 1981 and continue to September 1982. The construction of the major oil/gas processing units and general facilities will occur between January 1981 and September 1982.

Operations will continue from September 1982 to about the year 2040, when the resource interval will be exhausted.

1. Description of Mining

Multiple levels of access are required for full-scale in situ retort development and operation. The upper-most provides access and acts as an air plenum for distribution of air supplied to the retorts. Retort levels penetrate the retorts below the air level to allow creation of voids required for rubbling. The production level is below the retort and is used for withdrawal of oil shale removed during development and creation of retort voids. It also allows gathering of the oil and water produced from the retorts.

Immediately below the production level is the gas level, which contains the gas collecting drift through which the gaseous products of combustion are collected and carried to the gas shaft and then to the surface facilities for treatment.

The initial small shafts will be retained and used for ventilation, escape ways and mine dewatering.

The large-diameter production and service shafts will be used for ventilation and to supply air for the retorting process.

Detailed descriptions of mine development plans are included in Section III of the Modification to the DDP.

2. Description of In Situ Retorting

Retorts are created by mining out only enough shale to provide a void fraction for rubbling the remaining shale by blasting and to provide permeability for gas flow during operation. These in situ retorts consist of groups or "clusters" of eight 200ft x 200-ft x 310-ft-high rubble columns or chimneys. Undisturbed pillars function as control partitions between operating retorts.

The processing of a cluster of retorts consists of several steps. First, a retort within a cluster is kindled from the top by externally fueled burners. When the temperature at the top of the retort is sufficient to sustain reaction, the burners are shut off and a regulated mixture of air and steam is drawn into and through the retort by exhaust blowers on the surface. Residual organic material is combusted with the air in the feed gas. The hot combustion gases flow down through the retort and supply heat to the raw unretorted shale below. As the shale is heated, the organic material or kerogen decomposes into oil vapor and other gases that are carried along with the combustion gases while some residual organic material remains in the rubble. Steam in the feed gas acts as a diluent to the oxygen in the air to control the reaction temperature and reacts with the residual organic material, forming carbon monoxide and hydrogen to improve the heating value of the product gas. Some of the mineral carbonates in the shale are also decomposed to carbon dioxide gas and mineral oxides. At the same time, the oil and some of the water vapor are condensed. Product liquids and gas leave the bottom of the retort and move to the surface for further processing as a product oil, produced fuel gas, and water.

As retorting progresses, the combustion and retorting zones move slowly down through the in situ retort. Between 7 and 8 months are required to process a cluster. When retorting is complete, the air and steam feed are stopped and the in situ retort is closed off. The spent shale remains underground with no need for surface disposal.

Surface process facilities consist only of oil/water separation equipment, exhaust blowers, a sulfur removal unit for treatment of product gas, and boilers to produce process steam from fuel values in the product gas.

3. Water Supply and Disposal

Water requirements during development and for full-scale commercial operation are shown in Figure 5. Water will be available from the primary source, mine dewatering. Commercial operation will require about 2500 gpm. Present information indicates that water supply and requirements will essentially be in balance. Any deficiency will be made up either from on-tract wells or from off-tract sources.

If a surplus of water occurs, the excess will be stored and then either reinjected or treated and released.

4. Off-Tract Facilities

A staging area for materials and supplies will be required for off-tract facilities. This facility will be located near a rail siding in either Rifle or Grand Valley, Colorado.

With the expected arrival of Alaskan Crude on the West Coast, it is generally thought that the Four Corners area and the Texas-New Mexico crude oil lines will soon be filled with Alaskan crude and thus the proposed La Sal pipeline which would deliver shale oil into this area and on to a southern or a western market may not be attractive in the future.

The C-b Shale Oil Venture is studying an additional alternate pipeline route which will go generally north and east to tie in with an existing pipeline system which is reported to have 70,000 to 80,000 bbl/day of available space in Casper or Guernsey, Wyoming. This will allowshale oil to be delivered into the crude oil deficient northern tier and central states. A generalized routing for these pipelines is shown in Figure 6.

D. Post Operations

Because the shale oil complex is expected to have an operating life of about 56 years, it is difficult to predict at this time the disposition of the facility after the reserves within the current zone of interest are depleted. When the oil shale reserves have been depleted facilities will be removed, the area revegetated and shafts sealed to prevent injury to man and animals.

E. Resource Recovery

The shale interval from which oil will be extracted (310 feet) contains about 3.0 billion bbl in place. Of this, 1.2 billion bbls will be recovered by the In Situ Process. If the option is exercised to surface retort the mined out shale, the total recovery would be about 1.65 billion barrels.

Nahcolite and dawsonite are present to a very minor extent in the oil shale zones of Tract C-b, but these deposits are so dispersed and represent such low concentrations that it is deemed uneconomic to recover them.

FIGURE 5

COMPARISON OF WATER AVAILABILITY AND USE

| Status of Mine and Process Plant | Estimated Mine Water Available (gpm) | Estimated Mine and Process Water Usage (gpm) |
|---|---|---|
| Initial Retort Development | 400 - 1,000 | 310 |
| Retort Cluster Development | 800 - 2,000 | 460 |
| Commercial Operation | 2,000 - X | 2,500 gpm |

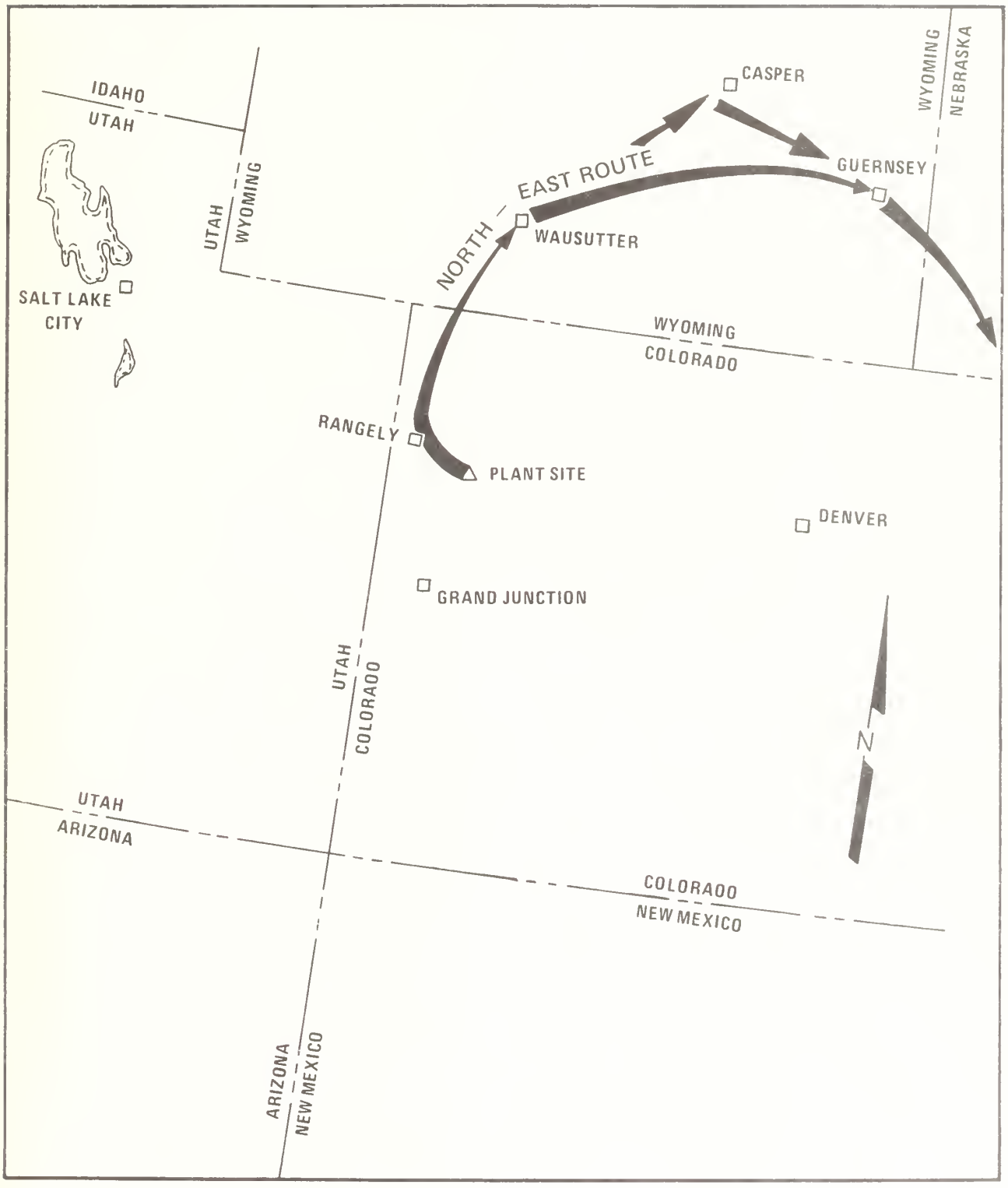


Figure 6 Crude Shale Oil Movement
Alternate Route

## V. SCHEDULE, MANPOWER AND COST ESTIMATES

### A. Schedule

Development, construction, operation, and eventual decommissioning of the proposed commercial oil shale complex is planned to proceed according to the schedule as set forth in Figure 4. Major facilities associated with the modified DDP project include: shafts and mine; ancillary development; and full-scale in situ mine and process.

In the last quarter of 1977, all activities necessary for major shaft sinking, site development, and final detailed engineering design will commence. The development sequence spans from the start of engineering and procurement (2/1/77) to beyond the starting date of the full-scale commercial in situ facility (9/1/82).

Milestone dates referenced to the Proposed Commercial Schedule, Figure 4, are as follows:

- 9/1/77 Start Construction Activities
- 5/1/80 Start Initial Retorts of Ancillary Facility
- 9/1/82 Start Operation of Full-Scale In Situ Plant

### B. Manpower

Manpower estimates are shown on Figure 7.

Over a 6-year period from 1977 to 1983 there will be a gradual increase in permanent site personnel to 1,600. After 1983 this number will remain constant. In addition to permanent personnel there are two periods during which temporary construction personnel will be onsite. The two periods are as follows:

| | Peak Total Employees | Permanent Employees |
|---|---|---|
| Ancillary Development | 1,180 | 750 |
| In Situ Construction | 2,900 | 1,600 |

In each period the buildup to peak personnel occurs over a period of about 2 years and then drops off in about 1 year.

### C. Cost Estimates

The following costs are based upon preliminary engineering design and project scheduling. These estimates assume favorable economic and political climates which allow proceeding on the planned schedules.

Capital cost estimates prepared for this document show overall project costs through the time of plant construction, but exclude interest during construction and deferred capital expenditures. Project estimates do not include escalation costs. Order-of-magnitude capital estimates for the modified in situ system are shown in Figure 8.

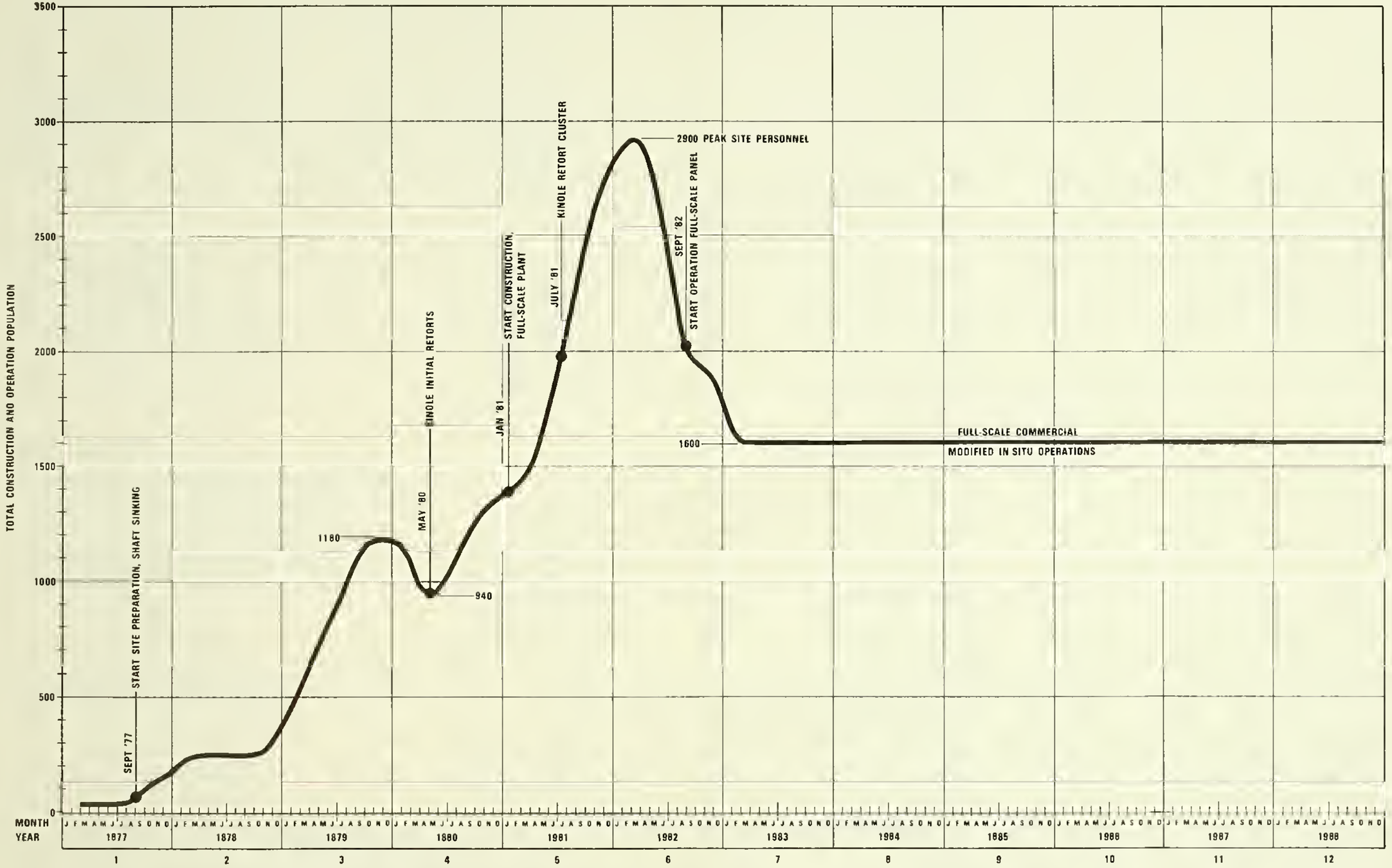


Figure 7 - Project Manpower Estimate

Figure 8 - Modified In Situ Estimated Capital Investment

| | |
|---|---|
| **Mine** | |
| Shafts, Hoist, and Appurtenances | $ 38,053,000 |
| Mobilization | 9,537,000 |
| Equipment and Spares | 21,450,000 |
| Conveyors and Materials Handling | 19,003,000 |
| Labor | 18,360,000 |
| Other Materials | 29,328,000 |
| Taxes | 965,000 |
| Subtotal | $136,696,000 |
| **Oil and Gas Processing** | |
| Steam Generation Plant | $ 21,060,000 |
| Water Treatment Plant | 36,250,000 |
| Gas Treatment Plant and Heater-Treater | 10,200,000 |
| Other Major Equipment | 15,568,000 |
| Other Materials | 12,405,000 |
| Taxes, Spare Parts and Miscellaneous | 3,036,000 |
| Field Indirects | 4,519,000 |
| Subtotal | $103,038,000 |
| **General Facilities** | |
| Emergency Generating Equipment, Package Boiler, Hoist, Cranes, Air Compressors, Storage Tanks, and Miscellaneous Equipment | $ 9,532,000 |
| Direct Materials, Concrete, Electrical Insulation, Roads, and Other Civil Work | 61,088,000 |
| Other Direct Costs, Spare Parts, Taxes, etc., | 2,984,000 |
| Field Indirects | 10,378,000 |
| Subtotal | 83,982,000 |
| Total Installed Equipment | $323,716,000 |
| Contractors Engineering, Home Office, Fees, Working Capital and Contingency | |
| Subtotal | $118,893,000 |
| TOTAL CAPITAL INVESTMENT | $442,609,000 |

## VI. OPTIONS AND ALTERNATIVES

Several options may present economically attractive alternatives as a supplement to the basic program described in this DDP Modification. The principal options envisioned at this time are:

- Surface Retorting of Mined-Out-Shale
- On-Site Electric Power Generation from Low-Btu Product Gas
- Alternative Water Supply and Management

Each of these cases is highly dependent upon economic and technical factors that cannot be determined at this time. However, considering the length of the program, it is conceivable that many of these factors will become definable, resulting in an alternate course that will be advantageous to the program.

These options are discussed in more detail in Section IV of Modification to the DDP.